

**RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN
BIG BROWN STEAM ELECTRIC STATION
ASH DISPOSAL AREA II
FREESTONE COUNTY, TEXAS**

OCTOBER 2016

Prepared for:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

Prepared by:

PASTOR, BEHLING & WHEELER, LLC
2201 Double Creek Drive, Suite 4004
Round Rock, Texas 78664
Texas Engineering Firm No. 4760

PBW Project No. 5196C

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the Run-on and Run-off Control System Plan has been prepared in accordance with the requirements of Section 257.81 of the CCR Rule.



Patrick J. Behling 10/05/16
Patrick J. Behling, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

LUMINANT

TABLE OF CONTENTS

	<u>Page</u>
PROFESSIONAL CERTIFICATION	i
LIST OF FIGURES	iii
LIST OF APPENDICES	iii
1.0 INTRODUCTION	1
1.1 CCR Landfill Run-on and Run-off Control System Plan Requirements	1
1.2 BBSES Units Subject to Run-on and Run-off Control System Plan Requirements	2
1.3 Description of Ash Disposal Area II Landfill	3
2.0 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN	4
2.1 Design Storm Conditions	4
2.2 Run-on Control System	4
2.2.1 Design and Construction	4
2.2.2 Operation and Maintenance	5
2.3 Run-off Control System	5
2.3.1 Design and Construction	6
2.3.2 Operation and Maintenance	9
2.4 Updates to Run-on and Run-off Control System Plan	9
3.0 REFERENCES	10

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LIST OF FIGURES

<u>Figure</u>	<u>Title</u>
1	Site Location Map
2	Site Vicinity Map
3	Existing ADA II Landfill Site Plan
4	Existing Drainage Scenario
5	Future Scenario: Cell 9/10 Full, CCR Disposal Occurring in Cell 11

LIST OF APPENDICES

<u>Appendix</u>	<u>Title</u>
A	US Department of Commerce Technical Paper No. 40, 25-Year, 24-Hour Rainfall Graph
B	HELP Model Results
C	Run-off Collection Area Containment Capacities
D	Run-off Volume Calculations

1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Big Brown Steam Electric Station (BBSES) located approximately 10 miles northeast of Fairfield, Texas in Freestone County (Figure 1). The BBSES consists of two coal/lignite-fired units with a combined operating capacity of approximately 1,150 Megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash and boiler slag are generated as part of BBSES unit operation.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of a run-on and run-off control system plan (RRCSP) for all CCR landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this run-on and run-off control system plan for the BBSES Ash Disposal Area II (ADA II) Landfill.

1.1 CCR Landfill Run-on and Run-off Control System Plan Requirements

Section 257.81(c) of the CCR Rule specifies that a written run-on and run-off control system plan be prepared for each existing CCR landfill that describes the systems that have been designed and constructed to control run-on to and run-off from the landfill consistent with the requirements of the CCR Rule and recognized and generally accepted good engineering practices. The RRCSP must include, at a minimum, design, construction, operation, and maintenance information for the following:

- A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and
- A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm. Run-off from the active portion of the CCR unit must be managed in accordance with the requirements of 40 CFR 257.3–3 (prohibition against pollution of waters of the United States).

The RRCSP must be supported by appropriate engineering calculations and must be certified by a qualified professional engineer. The RRCSP must document how the run-on and run-off control system has been designed and constructed to comply with the requirements of section 257.81 of the CCR Rule.

In accordance with 257.81(c)(3) of the CCR Rule, the initial RRCSP for an existing CCR landfill must be completed and placed in the facility operating record no later than October 17, 2016. Periodic RRCSPs must be completed every five years from the completion date of the initial plan. In addition, the RRCSP must be amended whenever there is a change in conditions that would substantially affect the plan.

1.2 BSES Units Subject to Run-on and Run-off Control System Plan Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The RRCSP requirements of the CCR Rule apply to existing and new CCR landfills that dispose of or otherwise engage in solid waste management of CCR.

The only CCR unit at the BSES that meets the definition of a CCR Landfill is the Ash Disposal Area II (ADA II) Landfill. The ADA II Landfill is located approximately 5,000 feet northeast of the power plant (Figure 2). This RRCSP was prepared for the ADA II landfill. In accordance with 257.81(c)(3) of the CCR Rule, the RRCSP must be amended when future landfill cells are constructed at the ADA II Landfill.

1.3 Description of Ash Disposal Area II Landfill

An existing site plan for the Ash Disposal Area II Landfill is shown on Figure 3. ADA II covers an area of approximately 240 acres and consists of ten active landfill cells (Cells 1 through 10), one landfill cell that has been constructed but not yet used (Cell 11), and nine future landfill cells (Cells 12 through 20). Cells 1 through 5 were constructed in sequence beginning in approximately 1987 (TUGC, 1986). Cells 6 through 11 were constructed in sequence beginning in approximately 1992 (SWL, 1992). The Ash Disposal Area II Landfill was registered with the Texas Commission on Environmental Quality (TCEQ) as a Class 2 non-hazardous industrial waste landfill in 1986 under SWR No. 30080 (ERM, 1986). The landfill registration was amended in 2009 to include Cells 11 through 20 (HDR, 2009). The portion of Ash Disposal Area II that consists of Cells 1 through 11 is considered an Existing CCR Landfill because the construction of the cells commenced prior to October 19, 2015 and the cells received CCR on or after

October 19, 2015. The portion of Ash Disposal Area II consisting of Cells 12 through 20 will be considered a Lateral Expansion and will be subject to the CCR Rule requirements for Lateral Expansions.

The landfill is constructed partially above and partially below grade and is surrounded by engineered earthen dikes that extend approximately 10 to 15 feet above the surrounding grade. Cells 1 through 11 have a 3-foot thick compacted clay liner (TUGC, 1986; SWL, 1992). Cells 12 through 20 are proposed to have a composite liner consisting of a high density polyethylene (HDPE) geomembrane and a geosynthetic clay liner (GCL) (HDR, 2009).

As of 2016, the majority of the surface areas of Cells 1 through 8 have been covered with either a permanent clay cap or a temporary soil cap (HDR, 2015). CCR placement is currently taking place in small portions of Cells 1, 2, 3 and 8 and in all of Cells 9 and 10 (See Figure 3). The permanent clay cap covers an area of approximately 17.5 acres along the west side of the landfill and also a small portion of the north side of the landfill (1.5 acres). The permanent clay cap consists of a minimum 3' thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} cm/sec or less topped by a minimum 18" thick vegetative soil layer (See Figure 3). The temporary soil cap covers an area of approximately 75 acres and varies in thickness from approximately 10 to 24 inches of sandy clay. Vegetation has already been established on these covered areas. The existing area where the permanent clay cap has been installed will be integrated with the overall permanent cover system as part of final landfill closure. A permanent landfill cap is proposed to be constructed on top of the areas covered with the temporary soil cap as part of final landfill closure.

2.0 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

The RRCSP for the Ash Disposal Area II Landfill is described in this section. In accordance with 257.81(c) of the CCR Rule, the RRCSP addresses run-on and run-off control for the active portion of the landfill. Run-on and run-off control systems for closed sections of the ADA II Landfill are described in the landfill's Closure Plan.

2.1 Design Storm Conditions

In accordance with Sections 257.81(a)(1) and 257.81(a)(2) of the CCR Rule, the run-on and run-off control systems for the landfill must be designed to prevent run-on into the landfill and run-off from the active portions of the landfill during the peak discharge from a 25-year 24-hour, storm. The US Department of Commerce has created Technical Paper No. 40: Rainfall Frequency Atlas of the United States (Hershfield, 1961). Technical Paper No. 40: Rainfall Frequency Atlas (TP-40) can be used to estimate design storm precipitation totals, including the 25-year, 24-hour storm. Based on the TP-40, the 25-year, 24-hour storm for Freestone County is 8.1 inches of rainfall. A copy of the appropriate TP-40 chart is shown in Appendix A.

2.2 Run-on Control System

The CCR Rule defines run-on as “any rainwater, leachate, or other liquid that drains overland onto any part of a CCR landfill or lateral expansion of a CCR landfill.” The run-on control system for the ADA II Landfill is described below.

2.2.1 Design and Construction

The ADA II Landfill has been designed and constructed to limit contact between storm water run-off from areas outside the landfill and CCR placed in the landfill. The landfill is surrounded by exterior earthen dikes that extend 10 to 15 feet or more above the surrounding grade. As shown on Figure 3, in accordance with Section 257.81(a)(1) of the CCR Rule, the height of the exterior landfill dikes relative to the surrounding topography will direct run-off from a 25-year 24-hour storm around the landfill and not allow it to flow into any part of the landfill actively receiving CCR.

The landfill dikes and storm water drainage features are also designed and constructed to minimize soil erosion. The exterior of the dikes, drainage features and other earth structures are permanently vegetated

to control erosion. Additional erosion protection (channel linings, rip rap, etc.) are used at locations with higher storm water flow velocities and increased erosion potential.

2.2.2 Operation and Maintenance

Storm water drainage features along the exterior of the ADA II Landfill will be operated and maintained to ensure that proper storm water run-on control is maintained throughout the life of the landfill. Storm water run-on operation and maintenance activities implemented at the landfill include:

- The landfill is visually inspected on a weekly basis by a qualified person in accordance 40 CFR 257.83(a) and annually by a professional engineer in accordance with 40 CFR 257.83 (b). The weekly and annual inspections address the exterior dikes around the landfill and storm water run-on control features along the dikes and include:
 - Verification that storm water generated from areas outside the CCR placement areas is diverted around the landfill by the dikes and associated drainage ditches, swales and other drainage features.
 - Verification that the drainage ditches, swales and other drainage features do not contain significant accumulated sediments or other flow obstructions;
 - Identification of areas of dike or drainage feature erosion/scouring that require repair.
- Accumulated sediment/debris are removed, as required, from the drainage features to maintain adequate storm water drainage. Areas of erosion/scour are repaired through backfilling, grading/reshaping, seeding and related activities. Drainage features may be redesigned/reconfigured if erosion/scouring are observed repeatedly in certain areas.
- Each inspection and maintenance activity is documented in a written inspection and maintenance record.

2.3 Run-off Control System

The CCR Rule defines run-off as “any rainwater, leachate, or other liquid that drains overland from any part of a CCR landfill or lateral expansion of a CCR landfill.” For the purposes of this RRCSP, this run-off is also referred to as being generated from either active, capped areas or previously reclaimed areas. The run-off control system for the ADA II Landfill is described herein.

2.3.1 Design and Construction

The ADA II Landfill has been designed and constructed to contain and control precipitation that falls directly on the unit's active portions. The landfill is surrounded by earthen dikes that extend 10 to 15 feet or more above the surrounding grade. Therefore, precipitation that falls within the active areas of the landfill is contained and managed within run-off collection areas. The base of each landfill cell is sloped toward a run-off collection area at the downgradient edge of the cell. Collected run-off is applied to the CCR to control dust, allowed to evaporate, or is pumped to the Operating Pond for reuse and/or make-up to specific consumptive plant processes. Run-off from areas with exposed CCR and run-off that mixes with run-off from areas with exposed CCR are not discharged from the landfill.

Luminant anticipates constructing the cap in phases over several years. While a landfill cell is active, all precipitation that comes into contact with exposed CCR will be contained and managed as run-off. Once a cell or portion of a cell has been closed/capped (either with a permanent cap or with a temporary soil cover), precipitation that falls on the closed/capped area will be considered clean run-off and will be diverted away from the active areas of the landfill. This clean storm water run-off will be diverted away from the landfill by the drainage ditches, swales and other surface features along the perimeter of the landfill. As discussed previously in Section 1.3, most of Cells 1-8 have already been filled to capacity and the majority of their surface areas have either a permanent or temporary cover (See Figure 3).

Luminant plans to continue placing CCR in the landfill cells relatively sequentially (See Figure 4). At this time, CCRs are being placed in small portions of Cells 1, 2, 3 and 8 and in all of Cells 9 and 10. As shown in Figure 4, any precipitation which falls into the active CCR placement area flows into Cell 10 and is retained or transferred to the Operating Pond. At this time, Cell 10 has adequate capacity to contain the volume of run-off which would be generated by the 25-year, 24-hour design storm (See Run-off Containment Capacity and Run-off Volume Calculations in Appendices C and D, respectively).

Before the capacity of the Cell 10 run-off collection area has decreased to a volume that is no longer sufficient to handle the peak run-off volume generated by the design storm, the CCR and interim dike system can be graded to direct storm water flow from the active CCR placement areas into Cell 11.

Cell 11's run-off collection area will have sufficient capacity to handle the design storm (See Appendices C and D). Before Cell 11 becomes filled with CCR to the point that its run-off collection area's storage volume is inadequate, Cell 12 will be constructed to provide the required additional run-off collection area storage volume.

This process will be repeated sequentially until the landfill has reached its design capacity, the BBSSES is no longer in operation, or Luminant has determined that the landfill is no longer necessary. At no time, will the landfill be operated without an adequate run-off control system.

Run-off Volume Calculations

As described in Appendix D, the required run-off collection area storage volumes were estimated using the Curve Number (CN) method described in USDA publication *TR-55 - Urban Hydrology for Small Water Sheds* (USDA-NRCS, 1986). A key parameter of the TR-55 procedure is the CN used in the evaluations. As a point of reference, a CN of 100 means 100 percent of the rainfall in an area runs off and none of the precipitation is retained by the exposed material through absorption, evaporation, localized ponding, infiltration and similar processes. Published CNs vary depending on material type, degree of saturation and other variables, ranging from 98 for impervious surfaces (concrete/asphalt pavement, etc.) to 50 or less for vegetated, well drained soils (USDA-NRCS, 1986). For this plan, the Hydrologic Evaluation of Landfill Performance (HELP) model was used to estimate a CN for the exposed CCR in the cells (Schroeder, et. al, 1994). HELP model results for the following three types of materials are shown in Appendix B:

1. Exposed CCRs
2. Exposed Protective Cover Soil (with good vegetation)

Based on the HELP model results, a CN of 94 is assumed for estimating run-off volumes generated from exposed CCRs and a CN of 68 is assumed for estimating water volumes generated from exposed protective cover soil with good vegetation (the covered portions of Cells contributing to flow into the run-off ponds).

Run-off Surface Areas and Volume Calculations

The cells' respective drainage boundary areas and their surface areas (for each type of surface contributing to the run-off peak volume) were determined using AutoCAD Civil 3D and assuming a minimum 2' of freeboard. When multiple cells are used to provide run-off containment, any precipitation onto and/or storm water run-on into the entire cell's drainage area has been included to calculate the amount of run-off volume generated by the design storm (since any water co-mingling with run-off from areas where CCR is exposed is also considered run-off that must be contained). The drainage boundaries and the surface area outputs from the Civil 3D models are shown in Figures 4 and 5.

Available run-off storage volumes for each cell were calculated using the terrain modelling capabilities of AutoCad Civil 3D. Volume outputs from the Civil 3D models showing the containment capacities of each landfill cell are shown in Appendix C and listed below.

Run-off containment capacities were calculated for the conditions described below.

- **Existing Configuration:** CCR is being placed in small portions of Cells 1, 2, 3 and 8 and in all of Cells 9 and 10. Run-off that is generated from precipitation that falls directly into the Cell 10 run-off collection area is shown in Figure 4.
- **Future Configuration:** Cells 9 and 10 full and capped, CCR placement is occurring in Cell 11. Run-off into Cell 11 is generated from precipitation that falls directly into the drainage area delineated in Figure 5.

The run-off peak volumes and run-off collection area storage volumes for each configuration were calculated to be the following:

Existing Configuration (Run-off contained in Cell 10):

- Existing Drainage Area Run-off Peak Volume: 1,167,102 cf
- Existing Run-off Collection Area Storage Capacity: 1,329,815 cf (with 2 feet freeboard)

Future Configuration (Run-off contained in Cell 11):

- Cell 11 Run-off Peak Volume: 601,544 cf
- Initial Cell 11 Run-off Collection Area Storage Capacity: 5,093,184 cf (with 2 feet freeboard)

This comparison of the estimated volumes of run-off to the run-off collection area containment capacities for the landfill cells confirms that adequate containment is and will be provided for the design storm.

2.3.2 Operation and Maintenance

The run-off containment features of the cells will be operated and maintained to ensure that proper run-off control is maintained throughout the life of the landfill. Run-off operation and maintenance activities implemented at the landfill include:

- Run-off generated at the landfill is stored in the landfill cells for the shortest time practicable. Stored run-off is applied to the CCR to control dust and/or is allowed to evaporate, or is pumped to the Operating Pond for reuse and/or make-up to specific consumptive plant processes. Run-off from areas with exposed CCR and run-off that mixes with run-off from areas with exposed CCR are not discharged from the landfill.
- The landfill is visually inspected on a weekly basis by a qualified person in accordance 40 CFR 257.83(a) and annually by a professional engineer in accordance with 40 CFR 257.83 (b). The

weekly and annual inspections address the interior and exterior dikes at the landfill and include:

- Verification that run-off is being contained in the landfill cells and a minimum of 2 feet of freeboard is maintained along the exterior dikes in areas where run-off is temporarily stored.
- Each inspection and maintenance activity is documented in a written inspection and maintenance record.

2.4 Updates to Run-on and Run-off Control System Plan

In accordance with 257.81(c)(3) of the CCR Rule, this initial RRCSP must be placed in facility operating record no later than October 17, 2016. Subsequent periodic RRCSPs must be completed every five years from the completion date of this initial plan. In addition, the RRCSP must be amended whenever there is a change in conditions that would substantially affect the plan.

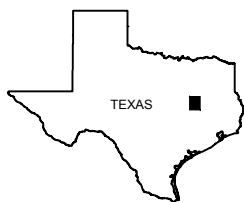
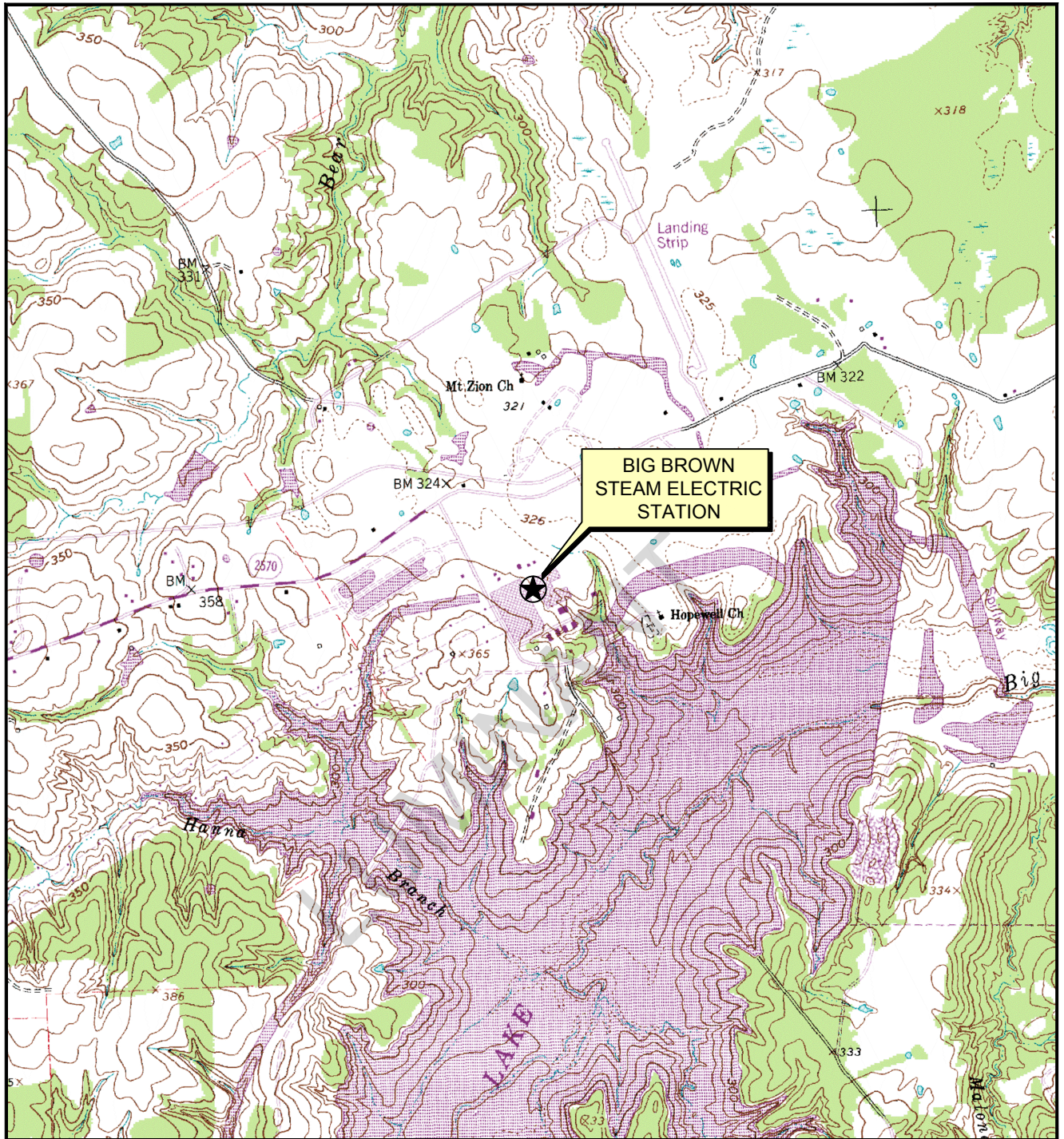
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- Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjoström, J.W. and Peton, R.L., 1994. *The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3*, EPA/600/R-94/168b, US. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Cincinnati, OH.

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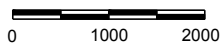
Figures



QUADRANGLE LOCATION



Scale in Feet



LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

PROJECT: 5196C

BY: ADJ

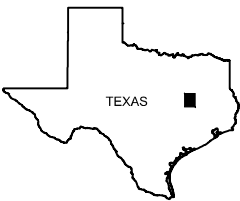
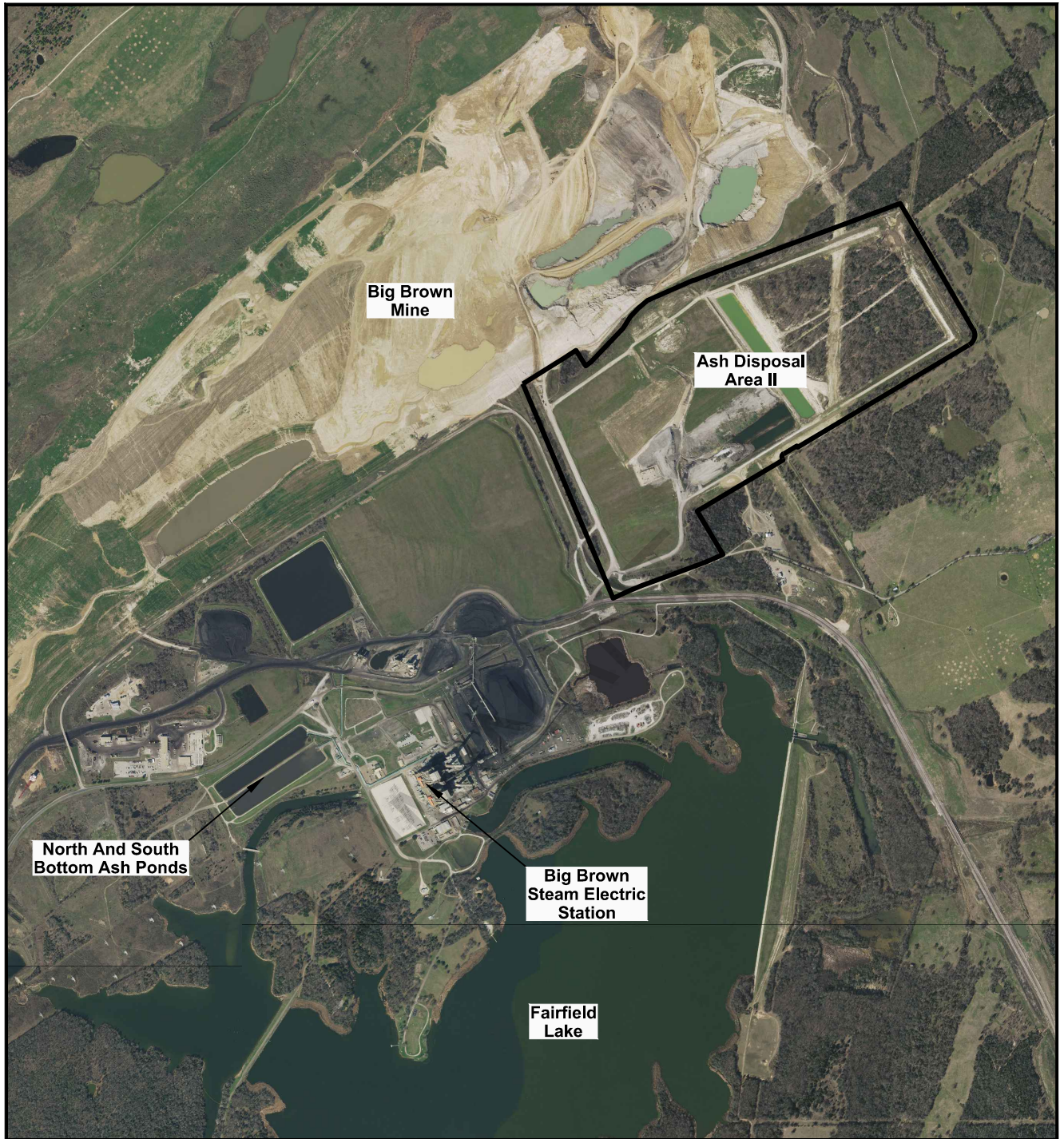
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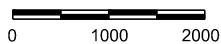
SOURCE:
 Base map from www.tnris.gov, Young, TX 7.5 min. USGS quadrangle dated 1961, revised 1982.



PHOTOGRAPH LOCATION



Scale in Feet



LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

PROJECT: 5196C

BY: ADJ

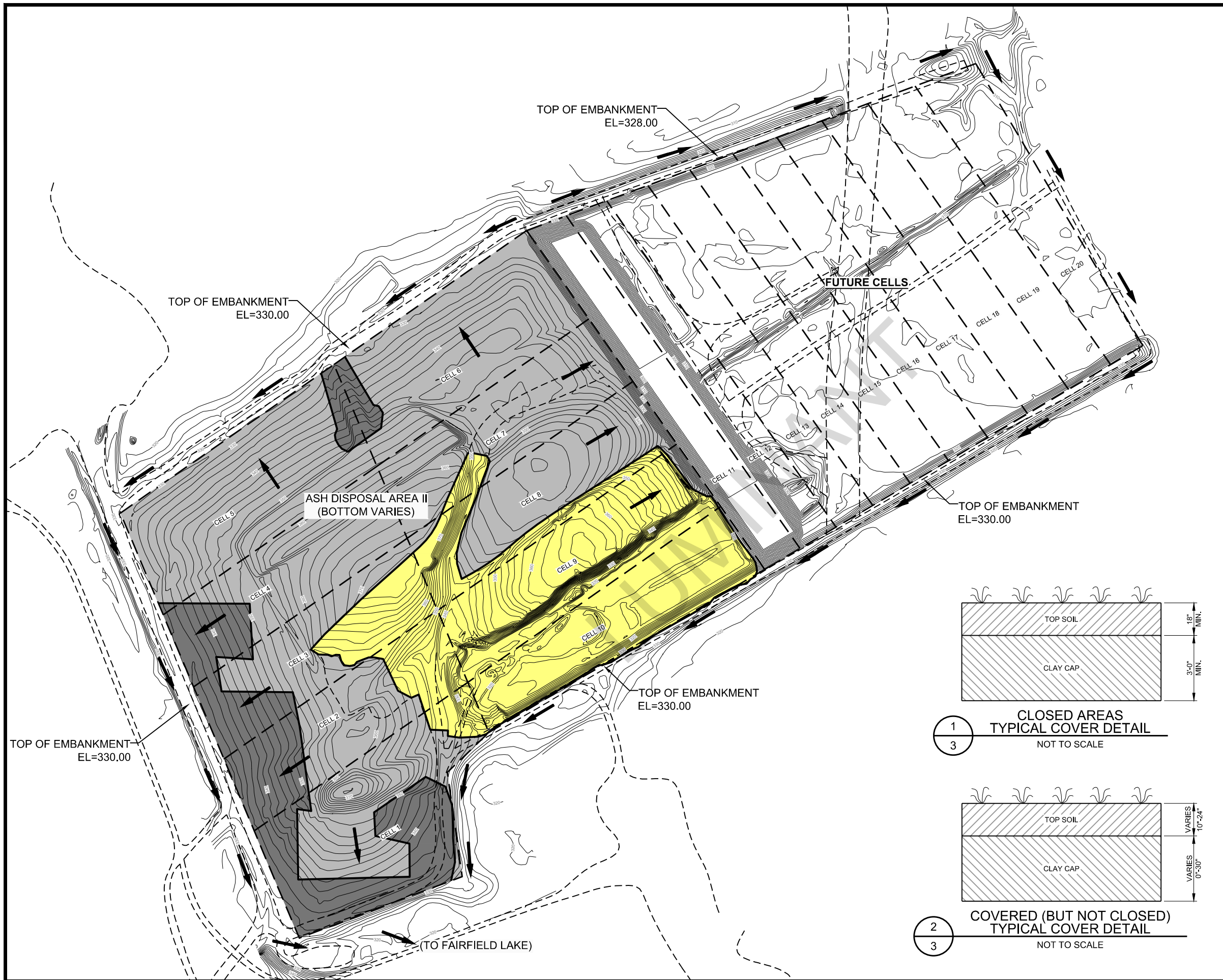
REVISIONS

DATE: OCT., 2016

CHECKED: RBL/PJB

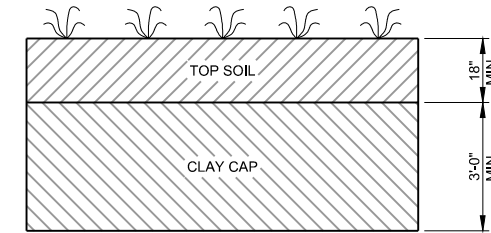
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SOURCE:
 Imagery from www.tnris.gov, Young, aerial photographs, 2015.

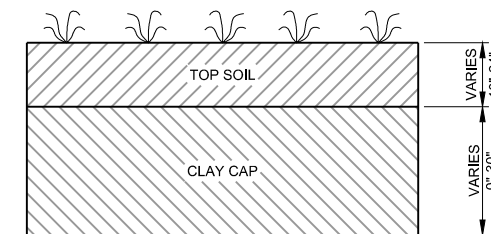


EXPLANATION

- Existing Grade Contour 2 ft Interval
- Existing Grade Contour 10 ft Interval
- - - Cell Boundary
- - - - Gravel Road
- █ Permanent Cover in Place (See Detail 1/3)
- █ Temporary Cover (See Detail 2/3)
- █ Active Area (Exposed CCRs)
- Stormwater Runoff Flow Direction



1
3
**CLOSED AREAS
TYPICAL COVER DETAIL**
NOT TO SCALE



2
3
**COVERED (BUT NOT CLOSED)
TYPICAL COVER DETAIL**
NOT TO SCALE

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BIG BROWN STEAM ELECTRIC STATION

Figure 3

PROPOSED GRADING PLAN

PROJECT: 5196C	BY: AJD/GJM	REVISIONS
DATE: OCT., 2016	CHECKED: RBL/PJB	

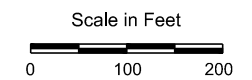
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EXPLANATION

- Existing Grade Contour 2 ft Interval
- Existing Grade Contour 10 ft Interval
- - - Cell Boundary
- - - - Gravel Road
- █ Permanent Cover in Place
- █ Temporary Cover
- █ Active Area (Exposed CCRs)
- ➔ Stormwater Runoff Flow Direction
- - - - Watershed Boundary (47.7 AC)

Drainage Area I.D.	Area (square feet)
Exposed CCRs	1,651,164
Vegetated Protective Cover	424,589



LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 4

EXISTING DRAINAGE SCENARIO

PROJECT: 5196C	BY: AJD/GJM	REVISIONS
DATE: OCT., 2016	CHECKED: RBL/PJB	

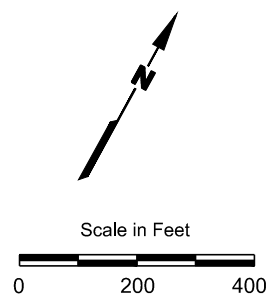
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EXPLANATION

- Existing Grade Contour 2 ft Interval
- 360— Existing Grade Contour 10 ft Interval
- - - Cell Boundary
- Cap Grade Contour 2 ft Interval
- 350— Cap Grade Contour 10 ft Interval
- Covered Area
- Active Area
- ➔ Stormwater Runoff Flow Direction
- - - Watershed Boundary (45.26 AC)

Drainage Area I.D.	Area (square feet)
Exposed CCRs	585,396
Vegetated Protective Cover	1,386,304



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BIG BROWN STEAM ELECTRIC STATION

Figure 5
FUTURE SCENARIO
CELL 9/10 FULL, CCR DISPOSAL
OCCURRING IN CELL 11

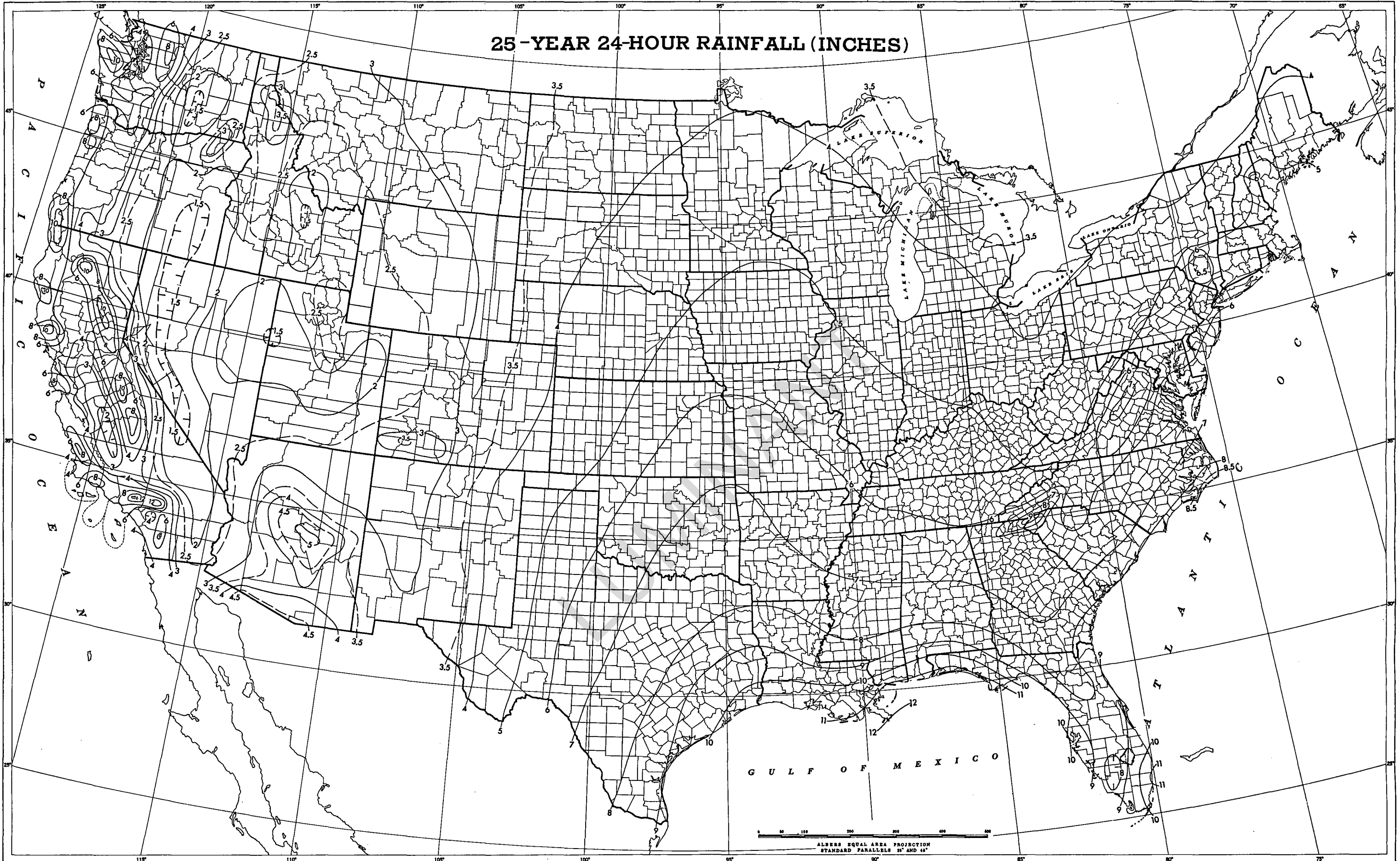
PROJECT: 5196C	BY: AJD/GJM	REVISIONS
DATE: OCT., 2016	CHECKED: RBL/PJB	

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Appendix A

**US Department of Commerce Technical Paper No. 40
25-Year, 24-Hour Rainfall Graph**

25-YEAR 24-HOUR RAINFALL (INCHES)



Appendix B

HELP Model Results

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**                                     **
**                                     **
** HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE **
** HELP MODEL VERSION 3.07 (1 November 1997) **
** DEVELOPED BY ENVIRONMENTAL LABORATORY **
** USAE WATERWAYS EXPERIMENT STATION **
**FOR USEPA RISK REDUCTION ENGINEERING LABORATORY**
**                                     **
**                                     **
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TIME: 16:12 DATE: 9/14/2016

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TITLE: Active Area
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30
THICKNESS = 304.80 CM
POROSITY = 0.5410 VOL/VOL
FIELD CAPACITY = 0.1870 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1934 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.500001120000E-04 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 5.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #30 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.0% AND A SLOPE LENGTH OF 213. METERS.

SCS RUNOFF CURVE NUMBER = 94.43
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 15.3416 HECTARES
EVAPORATIVE ZONE DEPTH = 25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE = 5.506 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 13.741 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.194 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 58.933 CM
TOTAL INITIAL WATER = 58.933 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Big Brown TX

STATION LATITUDE = 31.54 DEGREES
 MAXIMUM LEAF AREA INDEX = 4.50
 START OF GROWING SEASON (JULIAN DATE) = 55
 END OF GROWING SEASON (JULIAN DATE) = 336
 EVAPORATIVE ZONE DEPTH = 10.0 INCHES
 AVERAGE ANNUAL WIND SPEED = 11.30 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 69.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 69.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 62.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 69.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.69	2.04	1.99	3.79	4.73	2.58
1.78	1.95	3.18	3.06	2.24	1.92

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.20	50.50	58.10	67.10	74.20	81.90
85.90	85.60	79.20	68.80	57.00	49.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX
AND STATION LATITUDE = 31.85 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.55 1.34	2.09 2.09	2.15 2.90	2.75 2.97	4.74 2.08	2.79 1.61
STD. DEVIATIONS	0.89 1.79	1.12 1.88	1.33 1.85	1.79 1.49	2.76 1.16	1.43 0.98
RUNOFF						
TOTALS	0.141 0.390	0.295 0.477	0.340 0.786	0.616 0.919	1.498 0.385	0.660 0.231
STD. DEVIATIONS	0.171 0.710	0.333 0.770	0.367 0.756	0.662 0.859	1.400 0.437	0.599 0.270
EVAPOTRANSPIRATION						
TOTALS	1.462 1.034	1.657 1.416	2.087 2.012	2.377 1.699	3.024 1.057	2.446 1.291
STD. DEVIATIONS	0.564 1.166	0.617 1.004	1.039 1.181	1.105 0.841	1.306 0.518	1.054 0.489

PERCOLATION/LEAKAGE THROUGH LAYER 1

TOTALS	0.0897 0.0383	0.0773 0.0393	0.0787 0.0390	0.0683 0.0460	0.0540 0.0555	0.0427 0.0721
STD. DEVIATIONS	0.0381 0.0315	0.0268 0.0319	0.0293 0.0331	0.0273 0.0361	0.0304 0.0352	0.0309 0.0369

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.07 (5.295)	4000377.3	100.00
RUNOFF	6.736 (2.1055)	926982.77	23.172
EVAPOTRANSPIRATION	21.560 (3.3472)	2966916.86	74.166
PERCOLATION/LEAKAGE THROUGH LAYER 1	0.70100 (0.28857)	96464.673	2.41139
CHANGE IN WATER STORAGE	0.073 (1.1556)	10013.06	0.250

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.81	661905.54587	3000022
RUNOFF	3.398	467567.22663	3000022
PERCOLATION/LEAKAGE THROUGH LAYER 1	0.007327	1008.26120	300020
SNOW WATER	2.09	287598.3591	240014
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3342	
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0470	

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	25.3849	0.2115
SNOW WATER	0.000	

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**                                     **
**                                     **
** HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE **
** HELP MODEL VERSION 3.07 (1 November 1997) **
** DEVELOPED BY ENVIRONMENTAL LABORATORY **
** USAE WATERWAYS EXPERIMENT STATION **
**FOR USEPA RISK REDUCTION ENGINEERING LABORATORY**
**                                     **
**                                     **
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PRECIPITATION DATA FILE: C:\WHI\VHELP22\data\P6312.VHP\_weather1.dat
TEMPERATURE DATA FILE: C:\WHI\VHELP22\data\P6312.VHP\_weather2.dat
SOLAR RADIATION DATA FILE: C:\WHI\VHELP22\data\P6312.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA: C:\WHI\VHELP22\data\P6312.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE: C:\WHI\VHELP22\data\P6312.VHP\_392222.inp
OUTPUT DATA FILE: C:\WHI\VHELP22\data\P6312.VHP\O_392222.prt

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TIME: 16:30 DATE: 9/14/2016

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*****
TITLE: Covered Area
*****

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	304.80	CM
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2111	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.720001612800E-03	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 5.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 288. METERS.

SCS RUNOFF CURVE NUMBER	=	67.40
FRACTION OF AREA ALLOWING RUNOFF	=	100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	12.8811 HECTARES
EVAPORATIVE ZONE DEPTH	=	25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.018 CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.506 CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.159 CM
INITIAL SNOW WATER	=	0.000 CM
INITIAL WATER IN LAYER MATERIALS	=	64.358 CM
TOTAL INITIAL WATER	=	64.358 CM
TOTAL SUBSURFACE INFLOW	=	0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Big Brown TX

STATION LATITUDE = 31.54 DEGREES
 MAXIMUM LEAF AREA INDEX = 4.50
 START OF GROWING SEASON (JULIAN DATE) = 55
 END OF GROWING SEASON (JULIAN DATE) = 336
 EVAPORATIVE ZONE DEPTH = 10.0 INCHES
 AVERAGE ANNUAL WIND SPEED = 11.30 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 69.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 69.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 62.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 69.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.69	2.04	1.99	3.79	4.73	2.58
1.78	1.95	3.18	3.06	2.24	1.92

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.20	50.50	58.10	67.10	74.20	81.90
85.90	85.60	79.20	68.80	57.00	49.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Big Brown TX
AND STATION LATITUDE = 31.85 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.55	2.09	2.15	2.75	4.74	2.79
	1.34	2.09	2.90	2.97	2.08	1.61
STD. DEVIATIONS	0.89	1.12	1.33	1.79	2.76	1.43
	1.79	1.88	1.85	1.49	1.16	0.98
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.034	0.001
	0.008	0.001	0.008	0.015	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.098	0.006
	0.040	0.003	0.032	0.062	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	1.286	1.590	1.888	2.360	3.327	2.687
	1.183	1.554	2.167	1.823	1.149	1.371
STD. DEVIATIONS	0.566	0.613	1.045	1.058	1.436	1.153
	1.309	1.097	1.256	0.899	0.573	0.515

PERCOLATION/LEAKAGE THROUGH LAYER 1

TOTALS	0.5867	0.4764	0.4908	0.4856	0.5574	0.6823
	0.6557	0.5847	0.5232	0.4983	0.4870	0.5754
STD. DEVIATIONS	0.4364	0.2615	0.2672	0.1992	0.3631	0.7614
	0.4012	0.2363	0.1908	0.3820	0.2810	0.3482

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.07 (5.295)	3358797.4	100.00
RUNOFF	0.067 (0.1165)	7756.10	0.231
EVAPOTRANSPIRATION	22.385 (3.5428)	2586395.27	77.004
PERCOLATION/LEAKAGE THROUGH LAYER 1	6.60361 (2.16665)	762984.174	22.71599
CHANGE IN WATER STORAGE	0.014 (1.8457)	1661.91	0.049

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.81	555749.23569	3000022
RUNOFF	0.318	36706.93059	3000022
PERCOLATION/LEAKAGE THROUGH LAYER 1	0.195300	22564.99599	1600024
SNOW WATER	2.09	241473.3783	240014
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3845	
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0850	

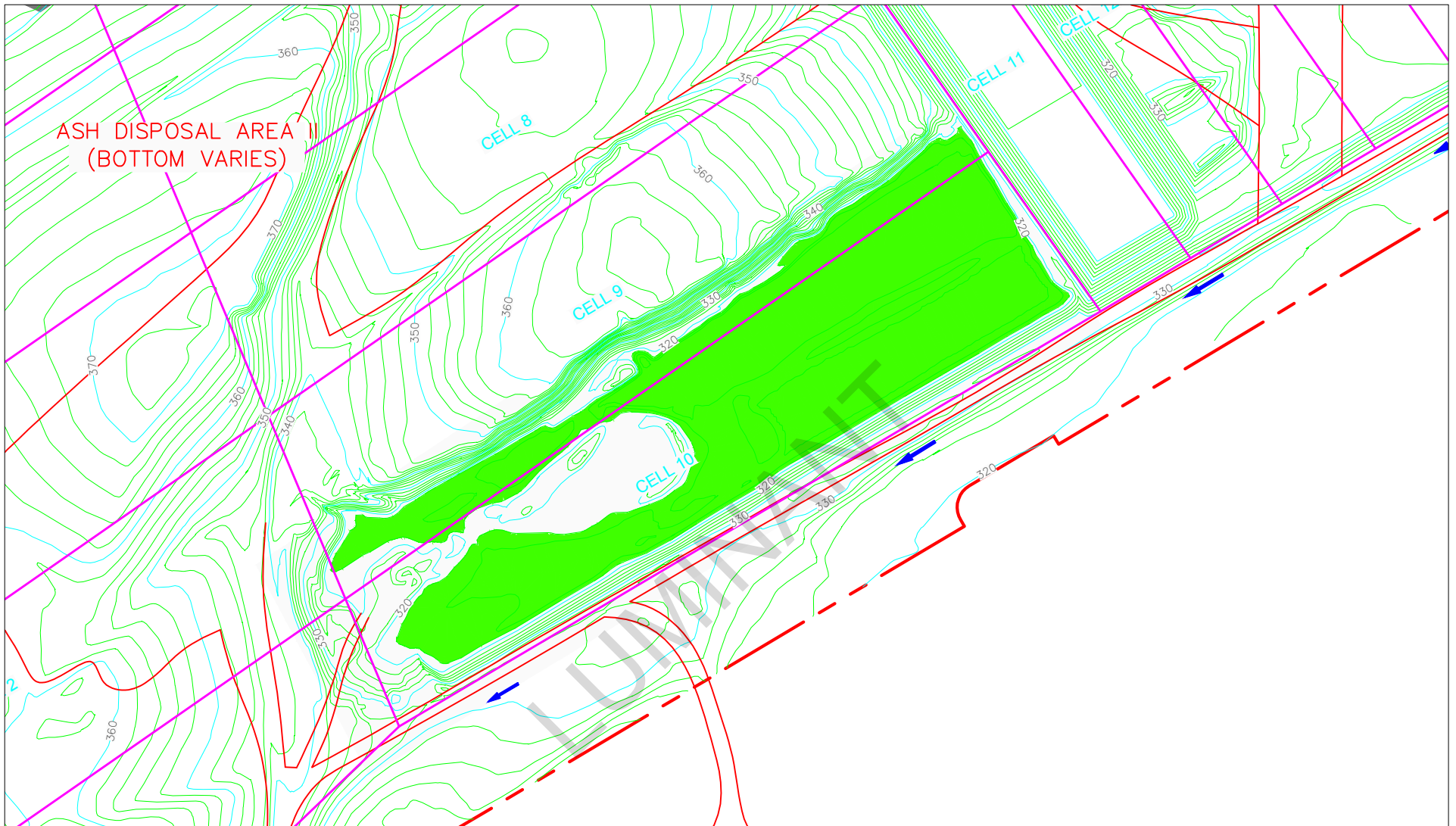
FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	25.7693	0.2147
SNOW WATER	0.000	

LUMINANT

Appendix C

Run-off Collection Area Containment Capacities



Explanation

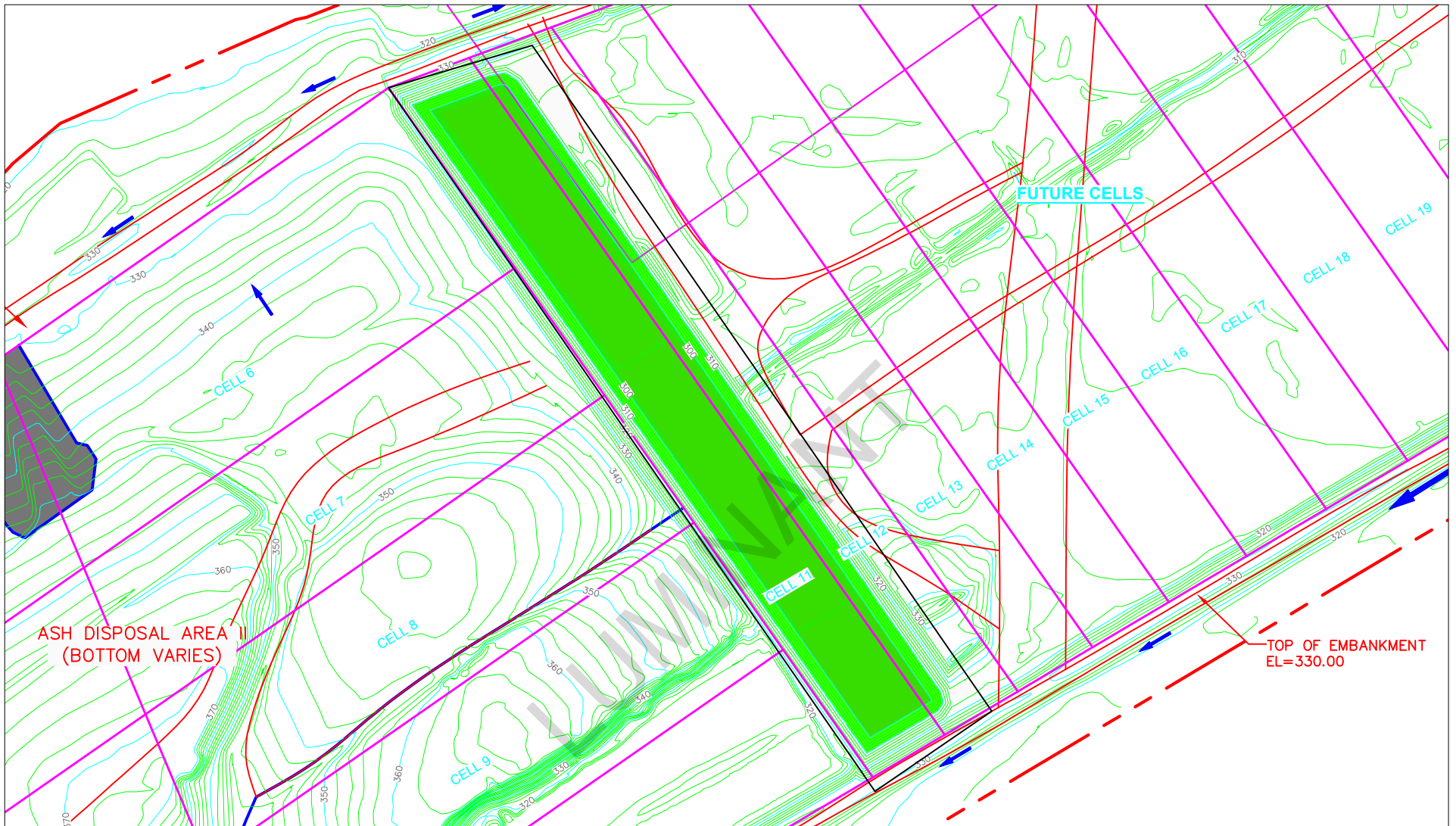


Extent of stormwater storage with 2 ft freeboard
(waterline elev. 318 ft.)

Storage = 1,329,815 cu. ft.

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
Stormwater storage (1)	0.000	1.000	874674.75 Sq. Ft.	0.00 Cu. Yd.	49252.39 Cu. Yd.	49252.39 Cu. Yd.<Fill>
Totals			874674.75 Sq. Ft.	0.00 Cu. Yd.	49252.39 Cu. Yd.	49252.39 Cu. Yd.<Fill>



Explanation



Extent of stormwater storage with 2 ft freeboard (waterline elev. 310 ft.)

Storage = 5,093,184 cu. ft.

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
Stormwater storage (1)	0.000	1.000	748018.54 Sq. Ft.	0.00 Cu. Yd.	188636.46 Cu. Yd.	188636.46 Cu. Yd.<Fill>
Totals			748018.54 Sq. Ft.	0.00 Cu. Yd.	188636.46 Cu. Yd.	188636.46 Cu. Yd.<Fill>

LUMINANT

Appendix D

Run-off Volume Calculations

APPENDIX D-1

**LUMINANT GENERATING COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION
ADA II LANDFILL - EXISTING CONFIGURATION
RUN-OFF VOLUME CALCULATIONS - ACTIVE AREA DRAINAGE AREA**

Definitions

Contact Water - Storm water that comes into contact with waste
 Non-contact Storm Water - Storm water that falls outside of an active waste management area and does not come into contact with waste

Assumptions

- 1) Portions of Cells 1, 2, 3, 7 and 8 and all of Cells 9 and 10 active (See Figure 4)
- 2) Contact and Non-Contact water is generated in the respective areas shown in Figure 4
- 3) Contact water volume based on a 25-year, 24-hr storm
- 4) Areas of assumed exposed fly and bed ash and vegetated protective soil shown in Figure 4
- 5) Storm water runoff volumes are estimated using the Curve Number method as described in USDA's Urban Hydrology for Small Water Sheds (TR-55)

Areas that Generate Contact Water

Exposed Fly Ash Surface Area: 1,651,164 sf
 Exposed Fly Ash Surface Area: 37.91 acres
 Vegetated Protective Cover Surface Area: 424,589 sf
 Vegetated Protective Cover Surface Area: 9.75 acres

Design Rainfall

From Technical Paper No. 40 for
 Freestone County 25-Yr, 24-hr: 8.10 in/day

Curve Numbers

From TR-55, Table 2-2a:
 - For exposed fly and bed ash, use CN = 94 (See HELP Model Results)
 - For vegetated protective soil, use CN = 68 (See HELP Model Results)

Calculate Weighted Curve Number for Site

Description	Area (acres)	CN	Area X CN
Exposed Fly and Bed Ash	37.91	94	3,563.1
Exposed Protective Soil	9.75	68	662.8
	47.65		4,225.9

Weighted Curve Number = (Sum of CN X A) / (Total Area)

Weighted Curve Number = 88.7

APPENDIX D-1

LUMINANT GENERATING COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION
ADA II LANDFILL - EXISTING CONFIGURATION
RUN-OFF VOLUME CALCULATIONS - ACTIVE AREA DRAINAGE AREA

Calculate Contact Water Volume Using TR-55 Procedures

1) Calculate Potential Retention of Water (S). Assume this represents water adsorbed by ash and protective cover (non free water)

$$S = (1000/CNW)-10$$

where: S = Potential Retention of Water, inches
CNW = Weighted Curve Number for Site

$$S = 1.28 \text{ inches}$$

2) Calculate Depth of Contact Water (Q)

$$Q = [(P-0.2S)^2]/[P-0.8S]$$

where: Q = Depth of contact water generated, inches
S = Potential Retention of Water, inches
P = Design rainfall, inches

$$Q = 6.75 \text{ inches}$$

3) Calculate Volume of Contact Water

$$V = Q \times A$$

where: Q = depth of contact water generated, ft
A = Total Area, sf

$$Q = 0.56 \text{ feet}$$

$$Q = 0.56 \text{ feet}$$

$$\text{Area} = 47.65 \text{ acres}$$

$$\text{Area} = 2,075,753 \text{ sf}$$

Total Contact Water Volume:	1,167,102 cf
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APPENDIX D-2

**LUMINANT GENERATING COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION
ADA II LANDFILL - FUTURE CONFIGURATION
RUN-OFF VOLUME CALCULATIONS - ACTIVE AREA DRAINAGE AREA**

Definitions

Contact Water - Storm water that comes into contact with waste
 Non-contact Storm Water - Storm water that falls outside of an active waste management area and does not come into contact with waste

Assumptions

- 1) Cells 9 and 10 are full and capped, Cell 11 is empty. See Figure 5.
- 2) Contact water is generated in the Cell 11 area. See Figure 5.
- 3) Contact water volume based on a 25-year, 24-hr storm
- 4) Areas of assumed exposed fly and bed ash and vegetated protective soil shown in Figure 5.
- 5) Storm water runoff volumes are estimated using the Curve Number method as described in USDA's Urban Hydrology for Small Water Sheds (TR-55)

Area that Generates Contact Water

Exposed Fly Ash Surface Area: 585,396 sf
 Exposed Fly Ash Surface Area: 13.44 acres
 Vegetated Protective Cover Surface Area: 1,386,304 sf
 Vegetated Protective Cover Surface Area: 31.83 acres

Design Rainfall

From Technical Paper No. 40 for
 Freestone County 25-Yr, 24-hr: 8.09 in/day

Curve Numbers

From TR-55, Table 2-2a:
 - For exposed fly and bed ash, use CN = 94 (See HELP Model Results)
 - For vegetated protective soil, use CN = 68 (See HELP Model Results)

Calculate Weighted Curve Number for Site

Description	Area (acres)	CN	Area X CN
Exposed Fly and Bed Ash (Cells 1 and 2)	13.4	94	1,263.3
Vegetated Protective Soil (Cell 2A)	31.8	68	2,164.1
	45.3		3,427.4

Weighted Curve Number = (Sum of CN X A) / (Total Area)

Weighted Curve Number = 75.7

APPENDIX D-2

LUMINANT GENERATING COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION
ADA II LANDFILL - FUTURE CONFIGURATION
RUN-OFF VOLUME CALCULATIONS - ACTIVE AREA DRAINAGE AREA

Calculate Contact Water Volume Using TR-55 Procedures

1) Calculate Potential Retention of Water (S). Assume this represents water adsorbed by ash and protective cover (non free water)

$$S = (1000/CNW)-10$$

where: S = Potential Retention of Water, inches
CN = Curve Number for Site

$$S = 3.21 \text{ inches}$$

2) Calculate Depth of Contact Water (Q)

$$Q = [(P-0.2S)^2]/[P-0.8S]$$

where: Q = Depth of contact water generated, inches
S = Potential Retention of Water, inches
P = Design rainfall, inches

$$Q = 5.21 \text{ inches}$$

3) Calculate Volume of Contact Water

$$V = Q \times A$$

where: Q = depth of contact water generated, ft
A = Total Area, sf

$$Q = 5.21 \text{ inches}$$

$$Q = 0.43 \text{ feet}$$

$$\text{Area} = 31.83 \text{ acres}$$

$$\text{Area} = 1,386,304 \text{ sf}$$

Total Contact Water Volume: 601,544 cf
